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Standard MICE/MEGS/MELT—SCENARIO Plasma Outputs Interface

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Technical Report

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13. ABSTRACT *(Maximum 200 words)* Version 1.031 of the standard output format for plasma quantities from the MICE, MEGS, MELT, and SCENARIO codes is documented. This format defines the arrangement and file structure used to convey quantitative information from numerical simulations of atmospheric effects generated by high-altitude nuclear explosions.			
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SUMMARY

This technical note outlines the MICE/MEGS/MELT - SCENARIO Plasma Outputs Interface specification, Version 1.031.

High-altitude nuclear phenomenology codes at the first-principles level (MICE/MEGS/MELT codes) and at the engineering-level (SCENARIO multiburst code) generate computer files which contain a variety of descriptors of the disturbed environment resulting from high-altitude nuclear detonations. Efficient and interchangeable use of results from these codes requires a common interface specification with sufficient generality to permit an end-user to accommodate basic differences between the codes and their outputs. This document represents the latest version of the standard file format. Publication coincides with distribution of SCENARIO, Version 4.0, which utilizes this Interface.

CONVERSION TABLE

Conversion Factors for U.S. Customary to metric (SI) unit of measurement

MULTIPLY ⟶ BY ⟶ TO GET
TO GET ⟵ BY ⟵ DIVIDE

angstrom	1.000000×10^{-10}	meters (m)
atmosphere (normal)	$1.01325\times10^{+2}$	kilo pascal (kPa)
bar	$1.000000\times10^{+2}$	kilo pascal (kPa)
barn	1.000000×10^{-28}	meter^2 (m^2)
British Thermal Unit	$1.054350\times10^{+3}$	joule (J)
calorie (thermochemical)	4.184000	joule (J)
cal/cm^2 (thermochemical)	4.184000×10^{-2}	mega joule/m^2 (MJ/m^2)
curie	3.700000×10^{-1}	*giga becquerel (GBq)
degree (angle)	1.745329×10^{-2}	radian (rad)
degree Farhenheit	$t_K = (t_F+459.67)/1.8$	degree kelvin (K)
electron volt	1.60219×10^{-19}	joule (J)
erg	1.000000×10^{-7}	joule (J)
erg/second	1.000000×10^{-7}	watt (W)
foot	3.048000×10^{-1}	meter (m)
foot-pound-force	1.355818	joule (J)
gallon (U.S. liquid)	3.785412×10^{-3}	meter^3 (m^3)
inch	2.540000×10^{-2}	meter (m)
jerk	$1.000000\times10^{+9}$	joule (J)
joule/kilogram (J/Kg) (radiation dose absorbed)	1.000000	Gray (Gy)
kilotons	4.183	terajoules
kip (1000 lbf)	$4.448222\times10^{+3}$	newton (N)
kip/inch^2 (ksi)	$6.894757\times10^{+3}$	kilo pascal (kPa)
ktap	$1.000000\times10^{+2}$	newton-s/m^2 (N-s/m^2)
micron	1.000000×10^{-6}	meter (m)
mil	2.540000×10^{-5}	meter (m)
mile (international)	$1.609344\times10^{+3}$	meter (m)
ounce	2.834952×10^{-2}	kilogram (Kg)
pound-force (lbs aviordupois)	4.448222	newton (N)
pound-force inch	1.129848×10^{-1}	newton-meter (N-m)
pound-force/inch	$1.751268\times10^{+2}$	newton/meter (N/m)
pound-force/foot^2	4.788026×10^{-2}	kilo pascal (kPa)
pound-force/inch^2 (psi)	6.894575	kilo pascal (kPa)
pound-mass (lbm avoirdupois)	4.535924×10^{-1}	kilogram (kg)
pound-mass-foot^2 (moment of inertia)	4.214011×10^{-2}	kilogram-meter^2 (kg m^2)
pound-mass/foot^3	$1.601846\times10^{+1}$	kilogram/meter^3 (kg/m^3)
rad (radiation dose absorbed)	1.000000×10^{-2}	**Gray (Gy)
roentgen	2.579760×10^{-4}	coulomb/kilogram (C/kg)
shake	1.000000×10^{-8}	second (s)
slug	$1.459390\times10^{+1}$	kilogram (kg)
torr (mm Hg, 0°C)	1.333222×10^{-1}	kilo pascal (kPa)

* The becquerel (Bq) is the SI unit of radioactivity; 1 Bq = 1 event/s

** The Gray is the SI unit of absorbed radiation.

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SECTION 1

INTRODUCTION

This document describes a revised Standard Plasma Outputs Interface format which is common to the SCENARIO, MICE/MEGS/MELT family of nuclear phenomenology codes sponsored by the Defense Nuclear Agency. The purpose of a standardized format is to enable easy transfer of information between nuclear phenomenology codes and post-processor / end-user codes.

In this context, post-processor codes augment basic environmental descriptors produced by the original phenomenology simulation, be it from SCENARIO or MICE/MELT. End-user codes typically use basic and/or post-processor-augmented phenomenology outputs to compute system performance parameters for operation in a nuclear environment.

For example, the PRPSIM post-processor code[1] directly uses nuclear phenomenology code outputs (e.g., SCENARIO or MICE/MELT results) to provide performance parameters associated with radio frequency communication links. An alternative operating mode directs basic phenomenology outputs (in Standard Format) to an intermediate post-processor. The intermediate post-processor i) calculates additional phenomenological quantities (e.g., structure descriptors such as outer scale, freezing scale, and spectral indices associated with a power spectral density) and ii) writes in Standard Format the original description of the burst-disturbed environment plus its additional quantities. Because the Standard Format is preserved in the process, PRPSIM and other post-processor / end-user codes can read and process the augmented file as well.

Although basic objectives of the Standard Plasma Outputs Interface had been accomplished by earlier versions of the format, recent systems requirements for additional phenomenology information, coupled with improved capabilities for predicting underlying nuclear burst effects, have forced revision.

Older versions of the format made allowances for future extension to include information about infrared environments from nuclear bursts. However, the infrared problem has proven sufficiently complex that it is desirable to separate MHD/plasma descriptors (electron density, ion species densities, neutral species densities, velocities, etc.) from information about infrared environments. The word "plasma" has been inserted into the title of this interface specification to emphasize the separation. A parallel document describes the standardized

format for infrared information.[2]

In many areas, organization of the Interface has been preserved without change. To accommodate new approaches to plasma structure modeling and extended descriptions of the power-spectral-density of plasma irregularities, a variety of changes to the record structure of the Standard Plasma Outputs Interface have been made. These rearrangements were motivated by DNA requirements plus a desire to minimize future changes as structure specifications become more refined.

To integrate new structure information into the Interface, structure parameters have been moved to a new location within the Environment Tube Records. (Note: terminology is summarized in the Glossary.) Environment Tube Records hold environmental descriptors (electron density, velocity, temperature, etc.) on a cell by cell basis. The new arrangement situates structure descriptors for ionized material in a new set of (optional) cell quantities located immediately after the "usual" quantities in the Environment Tube Records. Structure quantities are optional since not all high-altitude simulations will generate structure information. The presence or absence of these quantities is indicated by the value of the ISTRIR parameter in the Header Record. The number of structure quantities per cell, NSTRQ, is also a new parameter in the Header Record.

Another change of note involves addition of neutral fluid velocity information to the Environment Tube Records. This was done to provide a basis for post-processing with structure modeling techniques which use the differential velocity (slip velocity) between the ion-electron plasma and the neutral fluid.

Users of this Interface should pay particular attention to ordering and content of the revised Environment Tube Records. Revisions discussed above have forced a number of significant changes. Each has been flagged by an asterisk (*) in the margin. A few typographical errors from earlier versions of the Outputs Interface specification have also been repaired.

SECTION 2

INTERFACE SPECIFICATION

Numerical outputs from MICE/MELT or SCENARIO phenomenology simulations are generated at specific simulation times selected by the operator of the code. Information written to the program's output file is grouped into discrete clusters of records. Each cluster represents environmental conditions at a particular phase in the simulation. For purposes of discussion below, each cluster of records will be termed a code output block. In the phenomenology community, code output blocks are sometimes called "dumps" or "write-outs".

It is important to recognize that within an output file for a simulation, any code output block may differ in important ways from other code output blocks (i.e., other simulation times). For example, changes to computational grids might occur during a simulation, altering numbers, locations, and dimensions of computational cells. Changes of this sort could be triggered by a need to alter grid resolution as the simulation evolves. Numerous other shifts of basic simulation parameters are possible. The message: one cannot assume basic simulation parameters remain constant. The Header Record for each code output block should always be read.

The sub-sections which follow detail the structure of an individual block of code output. The sub-sections are organized to reflect the sequential record structure found in actual code output. FORTRAN syntax is used for mathematical expressions. FORTRAN naming conventions for distinguishing Real variables from Integers are followed.

2.1 HEADER RECORD.

Variable	Description	
IDENT	Alphanumeric identification of simulation. (80 characters)	
SOURCE	Alphanumeric identification of computer code used to generate simulation. (80 characters)	
CONTACT	Alphanumeric identifier of appropriate people to contact for resolution of phenomenology questions. (120 characters)	
COMMENT	General alphanumeric comments field. (80 characters)	
RUNDATE	Alphanumeric field containing time and date of simulation. (20 characters)	(*)
ISOURCE	Integer simulation source code ID: 1 = MICE 2 = MEGS 3 = MELT 4 = SCENARIO	
VERSION	Real variable denoting version number of Plasma Outputs Interface specification. Current version is 1.031, implemented 6/89.	(*)
TSIM	Simulation time (seconds) for this block of code output.	
ITIME	Simulation clock flag: 0 = Simulation time relative to an arbitrary reference (usually the first burst). 1 = Simulation time is GMT.	
NB	Number of bursts detonated prior to the writing of this block of code output.	
NRECS	Number of records (including this one) in the current block of code output.	

IGEOMR	Geometry flag: 1 = MICE 3-D modified Geocentric Spherical coordinates. 2 = Geomagnetic Dipole coordinates with aligned α array. 3 = Geomagnetic Dipole coordinates with staggered α array.
ISYMR	Grid symmetry flag: 0 = No symmetry 1 = Magnetic east-west reflection symmetry about ϕ=0 (or Y=0 in MICE output). 2 = North-south reflection symmetry about magnetic equator (or X=0 in MICE output). 3 = Both north-south and east-west reflection symmetries. 4 = Special symmetry — consult MRC phenomenologists.
IFGRID	Full grid output flag: 0 = Output block represents full computational grid. All environment tubes - both active and ambient. Total number of tubes, active plus ambient, is JMXB*JMXP. Number of active tubes is NATUBES. 1 = Output block contains active (non-ambient) environment tubes only. There are NATUBES active environment tubes. Ordering of active tubes within the grid is as specified by the Active/Inactive Environment Tube Record. Criteria used to determine which tubes are active depend on the particular code (ISOURCE).
NATUBES	Number of active environment tubes in this code output block.

NBUFF	Buffer size required to read Environment Tube Records. Nominal implementation is one environment tube per record, so minimum buffer size is (JMXA * NQPCEL + 3). To minimize interrecord gaps on magnetic tape, buffer size may optionally be increased to greater than or equal to an integer multiple of the minimum size. Consult MRC phenomenologists to arrange for larger buffer sizes.	(*)
JMXA	Number of grid cells in "vertical" direction. "Vertical" is the Z direction in MICE, but is the α direction in MEGS, MELT, and SCENARIO.	
JMXB	Number of grid cells in north-south direction. "North-south" is the X direction in MICE, but is the β direction in MEGS, MELT, and SCENARIO.	
JMXP	Number of grid cells in east-west direction. "East-west" is the Y direction in MICE, but is the ϕ direction in MEGS, MELT, and SCENARIO.	
NCELLS	Total number of grid cells in this code output block. If IFGRID = 0, then NCELLS = JMXA*JMXB*JMXP. If IFGRID = 1, then NCELLS = NATUBES*JMXA.	
NQPCEL	Number of quantities per cell in this code output block: 30 + NSTRQ for MEGS/MICE/MELT; 18 + NSTRQ for SCENARIO.	(*)
NSTRQ	Number of striation quantities per cell. Default value is 0 (if ISTRIR = 0) or 5 (if ISTRIR > 0).	(*)
LMXI	Number of ion species per cell. (Does not include weapon debris.)	
LMXN	Number of neutral species per cell.	
NAMB	Number of altitudes at which ambient atmosphere/ionosphere quantities are specified.	

ICHEMR — Integer chemistry model flag:
- 1 = Standard SCENARIO two reaction chemistry model.
- 2 = Standard MICE/MELT chemistry model.
- 3 = Standard MICE/MELT chemistry model plus D-region lumped-parameter chemistry.

IDEBRIS — Weapon debris flag:
- 0 = No debris density specified.
- 1 = Weapon debris density specified.

FBETA — Fraction of debris mass density that is a beta emitter.

FPHOT — Fraction of debris mass density that is an IR/visible scatterer.

IBETAR — Beta flux record flag:
- 0 = No Beta Flux Record written in this code output block.
- 1 = Beta Flux Record written.

ISTRIR — Striation model flag: (*)

If ISOURCE = 1 (MICE) --
- 0 = No striation parameters initialized, no striation quantities written.
- 1 = Local, linear striation analysis; striation quantities written.

If ISOURCE = 2 (MEGS) --
- 0 = No striation parameters initialized, no striation quantities written.
- 1 = Local, linear striation analysis; striation quantities written.

If ISOURCE = 3 (MELT) --
- 0 = No striation parameters initialized, no striation quantities written.
- 1 = Field-line-averaged striation growth plus regrid-variance accumulation; striation quantities written.
- 2 = Field-line-averaged striation growth plus regrid-variance accumulation plus striation convection; striation quantities written.
- 3 = Non-equipotential striation model parameters. (Not yet implemented)

If ISOURCE = 4 (SCENARIO) --
0 = no striation parameters initialized, no striation quantities written.
1 = standard SCENARIO striation convection parameters; striation quantities written.
2 = non-equipotential striation model parameters; striation quantities written. (Not yet implemented)

CLOR — Magnetic colatitude (radians) of origin of geocentric spherical grid (MICE outputs only, zero otherwise).

ELOR — East magnetic longitude (radians) of origin of geocentric spherical grid (MICE outputs only, zero otherwise).

ISPARE1

ISPARE2

ISPARE3

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.

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ISPARE9

2.2 BURST HISTORY RECORD.

(TIMEB(I), ZB(I), XB(I), YB(I), TYB(I), I=1,NBA) (*)

where:

TIMEB(I)	=	Detonation time of the I^{th} burst. (Bursts listed chronologically.)	(sec)
ZB(I)	=	"Vertical" coordinate of I^{th} burst point. Z coordinate (altitude) in geocentric spherical system (MICE);	(cm)
		α coordinate in geocentric dipole system (MEGS, MELT, SCENARIO).	(rad)
XB(I)	=	"North-south" coordinate of I^{th} burst point. X coordinate (positive to north) in geocentric spherical coordinate system (MICE);	(cm)
		β coordinate (positive toward magnetic equator) in geocentric dipole system (MEGS, MELT, SCENARIO).	(rad)
YB(I)	=	"East-west" coordinate of I^{th} burst point. Y coordinate (positive to west) in geocentric spherical coordinate system (MICE);	(cm)
		ϕ coordinate (positive to east) in geocentric dipole system (MEGS, MELT, SCENARIO).	(rad)
TYB(I)	=	Total Yield of I^{th} burst.	(MT)(*)
NBA	=	MAX(NB,1) (See Header Record for description of NB.)	

NOTE: If no detonations have occurred prior to the first code output block, then

NBA = 1, TIMEB = -1.E30,

ZB(1) = XB(1) = YB(1) = 0.,

TYB(1) = 0.

2.3 GRID GEOMETRY RECORD.

```
( ( ZKC(I,J), I=1,JMXA ), J=1,JMXB ),
( (DZKC(I,J), I=1,JMXA ), J=1,JMXB ),
( XKC(I), I=1, JMXB ),
(DXKC(I), I=1, JMXB ),
( YKC(I), I=1, JMXP ),
(DYKC(I), I=1, JMXP )
```

where:

ZKC = Array of cell-centered "vertical" coordinates. Z coordinate (altitude) in geocentric spherical coordinate system (MICE); (cm)
α coordinate in geocentric magnetic dipole coordinate system (MEGS, MELT, SCENARIO). The α unit vector is anti-parallel to the dipole geomagnetic field. (rad)
NOTE: ZKC is doubly subscripted to accommodate staggered α grids.

DZKC = Array of cell widths associated with ZKC. (cm or rad)
NOTE: DZKC is doubly subscripted to accommodate staggered α grids.
NOTE: For MICE only, altitudes of both the cell center and lower boundary of the bottom cell are defined to be the same. This oddity results from use of a reflective bottom boundary condition in the MICE finite difference scheme. (*)

XKC = Array of cell-centered "north-south" coordinates. X coordinate (positive toward north) in geocentric spherical coordinate system (MICE); (cm)
β coordinate (positive toward magnetic equator) in geocentric dipole coordinate system (MEGS, MELT, SCENARIO). (rad)

DXKC = Array of cell widths associated with XKC. (cm or rad)

YKC = Array of cell-centered "east-west" coordinates. Y coordinate (positive toward west) in geocentric spherical coordinate system (MICE); (cm)
ϕ coordinate (positive toward east) in geocentric dipole coordinate system (MEGS, MELT, SCENARIO). (rad)

DYKC = Array of cell widths associated with YKC. (cm or rad)

2.4 AMBIENT ATMOSPHERE/IONOSPHERE RECORD.

If ISOURCE = 1, 2, or 3 (MICE, MEGS, or MELT):

```
(Z(I), ENE(I), RHON(I), RHOI(I), TEMP(I), (SPEC(J,I), J=1,8),
     I=1,NAMB)                                                    (*)
```

If ISOURCE = 4 (SCENARIO):

```
(Z(I), ENEDAY(I), ENENITE(I), TEMP(I), RHON(I), I=1,NAMB)
```

where:

Z(I)	= Altitude of I^{th} entry in ambient table.	(cm)
ENE(I)	= Ambient electron density at I^{th} altitude.	(cm^{-3})
ENEDAY(I)	= Daytime ambient electron density at I^{th} altitude. (SCENARIO only.)	(cm^{-3})
ENENITE(I)	= Nighttime ambient electron density at I^{th} altitude. (SCENARIO only.)	(cm^{-3})
RHON(I)	= Ambient neutral mass density at I^{th} altitude.	(gm/cm^3)
RHOI(I)	= Ambient ion mass density at I^{th} altitude.	(gm/cm^3)
TEMP(I)	= Ambient temperature at I^{th} altitude.	(deg K)
SPEC(1,I)	= Ambient N_2 density at I^{th} altitude.	(cm^{-3})
SPEC(2,I)	= Ambient O_2 density at I^{th} altitude.	(cm^{-3})
SPEC(3,I)	= Ambient O density at I^{th} altitude.	(cm^{-3})
SPEC(4,I)	= Ambient NO density at I^{th} altitude.	(cm^{-3})
SPEC(5,I)	= Ambient H density at I^{th} altitude.	(cm^{-3})
SPEC(6,I)	= Ambient O^+ density at I^{th} altitude.	(cm^{-3})
SPEC(7,I)	= Ambient NO^+ density at I^{th} altitude.	(cm^{-3})
SPEC(8,I)	= Ambient H^+ density at I^{th} altitude.	(cm^{-3})

NOTE: See Header Record for description of **NAMB**.

2.5 ACTIVE/INACTIVE ENVIRONMENT TUBE RECORD.

((IMAP(I,J), I=1,JMXB), J=1,JMXP)

where:

IMAP(I,J) = Index map for active and inactive environment tubes. The (I,J) index corresponds to the $(I,J)^{th}$ (β,ϕ) grid location where $1 \le I \le JMXB$ and $1 \le J \le JMXP$.

0 = $(I,J)^{th}$ environment tube is inactive. IFGRID parameter in Header Record controls whether or not $(I,J)^{th}$ environment tube is written to output block.

n = Positive integer which indexes active environment tubes. Active tubes are written and numbered in sequential order as grid is scanned most rapidly along I index (β direction), least rapidly along J index (ϕ direction).

2.6 ENVIRONMENT TUBE RECORDS.

```
(IBETA,JPHI,KTUBE,((CQBUFF(NQ,NC,NT),
       NQ=1,NQPCEL), NC=1,JMXA), NT=1,NTBUFF)                    (*)
```

where:

IBETA = β index of environment tube.

JPHI = ϕ index of environment tube.

KTUBE = Active environment tube index.
- 0 = Inactive environment tube (if written).
- n = Active environment tube index as in IMAP(IBETA,JPHI).

CQBUFF = Array used to read cell quantities in environment tubes. Each tube record holds cell quantities for one or more complete environment tubes. No partial tubes are written. The number of complete tubes in a full buffer is the integer

NBUFF/(NQPCEL*JMXA+3) (*)

The first CQBUFF index runs over cell quantities:
$1 \le NQ \le NQPCEL$

The second CQBUFF index runs over cells in one environment tube:
$1 \le NC \le JMXA$

The third CQBUFF index runs over environment tubes:
$1 \le NT \le NTBUFF$

NOTE: For NTBUFF > 1, the last Environment Tube Record will generally contain fewer than NTBUFF tubes. This occurs because the total number of tubes may not be an integer multiple of NTBUFF.

CQBUFF(1,NC,NT) = Cell index (real variable) which runs over all cells (active plus inactive) in grid. This index is
NC + JMXA * (IBETA-1 + JMXB * (JPHI-1))

CQBUFF(2,NC,NT) = Electron number density. (cm^{-3})(*)
This quantity will be the <u>mean</u> electron density if striation convection is operative; i.e.,
if ISOURCE = 3 and ISTRIR = 2
or ISOURCE = 4 and ISTRIR = 1

CQBUFF(3,NC,NT) = Partial time derivative of electron density. This quantity will be a <u>mean</u> value if striation convection is operative. (This quantity will be zero unless specifically requested by the end user. Not available from standard SCENARIO simulations at present.) (cm^{-3}-sec^{-1})(*)

CQBUFF(4,NC,NT) = Debris mass density. (cm^{-3})(*)
Ionized weapon debris. This quantity will be a <u>mean</u> value if striation convection is operative. (This quantity is non-zero only if debris was initialized and transported in the simulation. See also IDEBRIS description in Header Record.)

CQBUFF(5,NC,NT) = Ion mass density. (gm/cm^3)

CQBUFF(6,NC,NT) = Ion velocity in the "vertical" direction. (cm/sec)
Z direction in geocentric spherical grid (MICE);
α direction in geocentric dipole grid (MEGS, MELT, SCENARIO).

CQBUFF(7,NC,NT) = Ion velocity in the "north-south" direction. (cm/sec)
X direction in geocentric spherical grid (MICE);
β direction in geocentric dipole grid (MEGS, MELT, SCENARIO).

CQBUFF(8,NC,NT) = Ion velocity in the "east-west" direction. (cm/sec)
Y direction in geocentric spherical grid (MICE);
ϕ direction in geocentric dipole grid (MEGS, MELT, SCENARIO).

CQBUFF(9,NC,NT) = Neutral mass density. (gm/cm^3)

CQBUFF(10,NC,NT) = Molecular mass fraction.
Neutral molecule mass density divided by total neutral mass density.

CQBUFF(11,NC,NT)	=	Neutral velocity component in the "vertical" direction. Z direction in a geocentric spherical grid (MICE, MELT, MEGS); α direction in a geomagnetic dipole grid SCENARIO).	(cm/sec)
CQBUFF(12,NC,NT)	=	Neutral velocity component in the "north-south" direction. X direction in a geocentric spherical grid (MICE, MELT, MEGS); β direction in geomagnetic dipole grid (SCENARIO).	(cm/sec)
CQBUFF(13,NC,NT)	=	Neutral velocity component in the "east-west" direction. Y direction in a geocentric spherical grid (MICE, MELT, MEGS); ϕ direction in geomagnetic dipole grid (SCENARIO).	(cm/sec)
CQBUFF(14,NC,NT)	=	"Vertical" component of magnetic field. Z direction in geocentric spherical grid (MICE); α direction in geocentric dipole grid (MEGS, MELT, SCENARIO).	(gauss)
CQBUFF(15,NC,NT)	=	"North-south" component of magnetic field. X direction in geocentric spherical grid (MICE); β direction in geocentric dipole grid (MEGS). Zero for MELT and SCENARIO by assumption of ambient geomagnetic field.	(gauss)
CQBUFF(16,NC,NT)	=	"East-west" component of magnetic field. Y direction in geocentric spherical grid (MICE); ϕ direction in geocentric dipole grid (MEGS). Zero for MELT and SCENARIO by assumption of ambient geomagnetic field.	(gauss)
CQBUFF(17,NC,NT)	=	Electron temperature. (Plasma temperature if ISOURCE=4 (SCENARIO).)	(deg K)
CQBUFF(18,NC,NT)	=	Neutral temperature.	(deg K)

END of Standard SCENARIO Quantities

Extended Phenomenology Quantities

The following quantities will be present if ISOURCE = 1, 2, or 3 (i.e., MICE, MEGS, or MELT, respectively). If present, use NS = 18 below. If ISOURCE = 4 (SCENARIO), these temperature and species quantities are not present. Skip to structure quantities.

CQBUFF(NS+1,NC,NT)	= N_2 vibrational temperature.	(deg K)
CQBUFF(NS+2,NC,NT)	= Ion temperature.	(deg K)
CQBUFF(NS+3,NC,NT)	= N^+ density. This quantity will be a <u>mean</u> value if striation convection is operative. (See CQBUFF(2,NC,NT).)	(cm^{-3})
CQBUFF(NS+4,NC,NT)	= O^+ density. This quantity will be a <u>mean</u> value if striation convection is operative. (See CQBUFF(2,NC,NT).)	(cm^{-3})
CQBUFF(NS+5,NC,NT)	= NO^+ density. This quantity will be a <u>mean</u> value if striation convection is operative. (See CQBUFF(2,NC,NT).)	(cm^{-3})
CQBUFF(NS+6,NC,NT)	= H^+ density. This quantity will be a <u>mean</u> value if striation convection is operative. (See CQBUFF(2,NC,NT).)	(cm^{-3})
CQBUFF(NS+7,NC,NT)	= N_2 density.	(cm^{-3})
CQBUFF(NS+8,NC,NT)	= O_2 density.	(cm^{-3})
CQBUFF(NS+9,NC,NT)	= NO density.	(cm^{-3})
CQBUFF(NS+10,NC,NT)	= N density.	(cm^{-3})
CQBUFF(NS+11,NC,NT)	= O density.	(cm^{-3})
CQBUFF(NS+12,NC,NT)	= H density.	(cm^{-3})

END of Standard MICE/MEGS/MELT Quantities

Optional Structure Descriptors

NQ = 30 if ISOURCE = 1, 2, or 3 (MICE, MEGS, or MELT).
   = 18 if ISOURCE = 4 (SCENARIO)
If ISTRIR = 0, then these structure quantities are omitted.

CQBUFF(NQ+1,NC,NT) = 1^{st} striation quantity. See Table 1.

CQBUFF(NQ+2,NC,NT) = 2^{nd} striation quantity. See Table 1.

CQBUFF(NQ+3,NC,NT) = 3^{rd} striation quantity. See Table 1.

CQBUFF(NQ+4,NC,NT) = 4^{th} striation quantity. See Table 1.

CQBUFF(NQ+5,NC,NT) = 5^{th} striation quantity. See Table 1.

END of ENVIRONMENT TUBE Cell Quantities

NOTE: NTBUFF is a user computed implied DO loop limit. User must keep track of how many environment tubes have been previously read from the current output block. If NTPREV is the number previously read, and if NAVAIL is the number of tubes in an output block (JMXB*JMXP if IFGRID=0, NATUBES if IFGRID=1), then

NTBUFF = MIN(NAVAIL-NPREV, NBUFF/(NQPCEL*JMXA+3))   (*)

This calculation must yield an integer greater than zero.

NOTE: Proper interpretation of Striation Quantities in Table 1 requires background knowledge of methodologies for computing descriptors of plasma striations. References 3 and 4 are recommended.

TABLE 1. Striation Quantities Definition.

For ISOURCE = 1 (MICE) or 2 (MEGS)

Striation Quantity Number	ISTRIR 1	ISTRIR 2
1	Time integrated local growth rate	Not Defined
2	Instantaneous local growth rate (sec^{-1})	Not Defined
3	Not Defined	Not Defined
4	Not Defined	Not Defined
5	Not Defined	Not Defined

For ISOURCE = 3 (MELT)

Striation Quantity Number	ISTRIR 1	ISTRIR 2
1	Field-line-averaged amplitude (0→1)	Field-line-averaged amplitude (0→1)
2	σ_n from regrids (cm^{-3})	σ_n from regrids and convection (cm^{-3})
3	Not Defined	High n_e (cm^{-3})
4	Not Defined	Low n_e (cm^{-3})
5	Not Defined	High / Low Area Ratio

TABLE 1. Striation Quantities Definition (continued).

For ISOURCE = 4 (SCENARIO)

Striation Quantity Number	ISTRIR 1	ISTRIR 2
1	σ_n from convection (cm^{-3})	Reserved for algorithm with outer scale calc.
2	Field-mapped outer scale (cm/rad)	Reserved
3	High n_e (cm^{-3})	Reserved
4	Low n_e (cm^{-3})	Reserved
5	High / Low Area Ratio	Reserved

2.7 BETA FLUX RECORD (Optional).

((BETAF(I,J), I=1,JMXB), J=1,JMXP)

where:

BETAF(I,J) = Beta particle energy flux (ergs/sec/cm^2) through a surface at 100 km altitude.

The surface in question is contained entirely within the $(I,J)^{th}$ environment tube and is perpendicular to the geomagnetic field. It is the center of this surface which is at 100 km altitude.

NOTE: This record is optional. The Header Record parameter **IBETAR** indicates if this record is present.

SECTION 3

LIST OF REFERENCES

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2. White, W.W., "Standard MICE/MELT - SCENARIO Infrared Outputs Interface", MRC/NSH-N-89-003, Mission Research Corporation, July 1989. (In preparation)

3. Holland, D.H., et al, "Physics of High-Altitude Nuclear Burst Effects", DNA 4501F, Mission Research Corporation, December 1977. See Chapter 13.

4. Stagat, R.W., D.S. Sappenfield, and J.P. Incerti, "The SCENARIO Code: Modifications in Version II and the Striation Convection Theory", AFWL-TR-80-124, Mission Research Corporation, April 1982.

APPENDIX

GLOSSARY OF TERMS

Active Environment Tube: See "Environment Tube".

Aligned α Array: Boundaries between cells along the α direction within an environment tube (magnetic flux tube) are contiguous with α boundaries in adjacent tubes. Consequently, α cell boundaries form continuous grid surfaces which are everywhere perpendicular to **B**. See also "Staggered α Array".

Code Output Block: A cluster of records within a file which describe the environment at a specified output time in a nuclear burst simulation. Sections 2.1 through 2.7 describe the contents of a code output block. Different code output blocks describe conditions at different times or under different circumstances. Also referred to as an Output Block.

Environment Tube: For output purposes, computational cells aligned with a selected coordinate direction have been grouped in linear arrays. Each linear array can be thought of as a "tube" of cells. Collectively all of the environment tubes in a code output block completely cover the three-dimensional computational volume (subject to symmetry restrictions — see "Grid Symmetry").

Environment tubes from MEGS, MELT, and SCENARIO are aligned with the ambient geomagnetic field and, thus, constitute magnetic flux tubes. Each cell in this type of environment tube contains an equal amount of magnetic flux, so the cross-sectional area of cells varies inversely with **B**.

Environment tubes from MICE are oriented along radial lines from the center of the earth. Consequently their cross-sectional area varies as $1/R^2$.

Historically, environment tubes have been known as "sticks", "tubes", "flux tubes", "plasma tubes",

or "columns" depending on context. Environment tubes may come in two varieties — active and inactive. Active tubes contain cell quantities which deviate from ambient due to the action of nuclear explosions. Inactive tubes contain only ambient atmospheric densities, temperatures, etc.

Grid Symmetry: No symmetry implies the complete three-dimensional grid is provided in the code output block.

Magnetic east-west reflection symmetry means reflection symmetry about the vertical magnetic meridian plane through the center of the computational volume was imposed on the simulation. In this case, only the half-space used for computation has been written out in the code output block.

Magnetic north-south reflection symmetry is similar to east-west reflection symmetry except the vertical reflecting plane is oriented east-west. In MEGS, MELT, and SCENARIO, the reflection plane is the magnetic equator. In MICE, the reflection plane occurs at X = 0.

High-β Plasma: Plasma with energy density well above the magnetic energy density. Plasma β is the ratio of plasma energy density to magnetic energy density. Either plasma thermal energy density or the sum of thermal + kinetic energy densities is commonly used in computing plasma β. Plasma β should not be confused with the β coordinate (geomagnetic dipole-field-aligned coordinates used in MELT, MEGS, and SCENARIO).

High/Low Area Ratio: Ratio of transverse-to-B areas occupied by High and Low n_e's within a computational cell. See Reference 4 and "High n_e", "Low n_e".

High n_e: Larger of two electron densities assumed by Stagat's two-level closure relation in Striation Convection theory. See Reference 4.

Inactive Environment Tube: See "Environment Tube".

Low n_e: Smaller of two electron densities assumed by Stagat's two-level closure relation in Striation Convection theory. See Reference 4.

MEGS: A first-principles, three-dimensional, two-fluid magnetohydrodynamics (MHD) code for computing evolution of high-β plasma. MEGS is similar to MICE in using detailed two-fluid MHD equations to treat high-β plasma; the code is similar to MELT in using a global-scale geomagnetic dipole-field-aligned coordinate system. The name MEGS derives from MHD Extended to Global Scale.

MELT: A first-principles, three-dimensional, two-fluid magnetohydrodynamics (MHD) code for computing evolution of low-β plasma. MELT's use of a geomagnetic dipole-field-aligned coordinate system permits tracking of air plasma (generated by high-altitude nuclear explosions) over global-scale distances. Two-fluid equations like those in MICE are used to represent physical processes. However, following the assumption of low-β plasma, MELT treats the geomagnetic field as ambient. Plasma transport across the geomagnetic field is via **E** x **B** drift where **E** is a self-consistent, spatially and temporally varying electrostatic field. The name MELT derives from Mixed Eulerian Lagrangian Two-fluid.

MICE: A first-principles, three-dimensional, two-fluid magnetohydrodynamics (MHD) code for computing evolution of high-β plasma. MICE uses a specialized geocentric spherical coordinate system to compute the dynamics of interpenetrating neutral and ion-electron fluids. Collisions at the atomic level transfer momentum and energy between fluids. Chemical reactions convert species of one fluid to the other, as appropriate. Maxwell's Equations are the basis for computing spatially and temporally varying electromagnetic fields. The name MICE derives from MHD Implicit Continuous Eulerian.

n_e: Electron density.

Output Block: See "Code Output Block".

Regrid: The act of transferring information (i.e., cell quantities) carried on one computational grid to another. For example, one may be motivated to regrid a computation into a larger grid when the edge of an expanding fireball approaches the existing grid's boundaries. Sometimes called a "rezone".

SCENARIO: A physics-based, engineering-level atmospheric effects code designed specifically to simulate multiple high-altitude nuclear detonations. Credibility of code outputs combined with computational speed derives from use in SCENARIO of truncated forms of the same three-dimensional, two-fluid magnetohydrodynamics equations used in MICE and MELT. SCENARIO is available to qualified users under License from the Defense Nuclear Agency.

Staggered α Array: Boundaries between cells along the α direction within an environment tube (magnetic flux tube) are not contiguous or aligned with α boundaries in adjacent tubes. Consequently, α cell boundaries do not form continuous grid surfaces. See also "Aligned α Array".

σ_n: Standard deviation of electron density; i.e., square root of electron density variance. See "Striation Convection".

Striation Convection: Computational algorithm for estimating electron density variance (σ_n^2) produced by the Gradient Drift Instability. A specialized algorithm is required because phenomenology codes cannot compute fine-scale plasma irregularities (striations with scale sizes as small as ~ 100 m) and simultaneously span the widespread volume

which is disturbed by even one nuclear burst (i.e., hundreds to thousands of kilometers in extent). In the context of plasma structure, striation convection is sometimes referred to simply as "convection". See Reference 4.

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